The Use of Methylene Blue Staining Test in Determining the CSF Leaks Location of the Anterior Skull Base

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Cerebrospinal fluid rhinorrhea represents drainage of cerebrospinal fluid into the nasal cavity. The first steps in diagnosing CSF rhinorrhea are a thorough history and physical examination of the patient. Other diagnostic procedures are the double ring sign, glucose content of the nasal fluid, Beta-trace protein test or beta 2-transferrin. To establish the exact location of the defect imagistic examinations are necessary. However, the gold standard CSF leakage diagnostic method is an intrathecal injection of fluorescein with the endoscopic identification of the defect. In this paper we analyze a staining test, using Methylene Blue solution, to identify the CSF leak's location.

Keywords: Methylene Blue staining test, CSF leaks, anterior skull base

Cerebrospinal fluid rhinorrhea represents a drainage of cerebrospinal fluid into the nasal cavity. Fluid leakage is the result of a fistula at the level of the meningeal layers [1].

This medical condition is rare but with an increased mortality potential due to complications, caused by the communication between the endocranial space and the sinonasal mucosa, the most common being meningitis [1].

The choroid plexuses and fourth ventricles mainly produce cerebrospinal fluid, but ependymal cells also provide a small amount. Afterwards it passes to the subarachnoid space and finally it is absorbed by the arachnoid villi into the venous circulation and lymphatic vessels [2].

The CSF rhinorrhea's etiology is categorized into traumatic and non-traumatic[20]. The majority of CSF fistulas is traumatic, about 80%, and is encountered in patients with head and neck trauma. In 55% of cases, these patients develop CSF fistulas in the first 48 h and up to 70% develop them in the first 7 days after the traumatic incident [3].

Surgical procedures, like FESS, skull base tumor surgery or pituitary surgery, are responsible for nearly 16% of CSF leaks in the anterior skull base and non traumatic CSF leaks represent only 4% [4-6].

The non-traumatic leaks are, in their turn, divided into normal-pressure and high-pressure fistulas. Normal-pressure fistulas are caused by congenital anomalies, osteomyelitis or they are idiopathic, whereas high-pressure fistulas occur due to hydrocephalus or tumor development that increase the pressure of the CSF [7-9].

The first steps in diagnosing CSF rhinorrhea are a thorough history and physical examination of the patient. The history includes: traumatic events, surgery, the characteristics of the nasal drainage, the duration of the rhinorrhea, complications, prior treatment. The physical examination consists in endoscopy of the nasal cavity, osteomeatal complex and the Eustachian tube orifice and also collecting nasal drainage for further analysis [10].

Other diagnostic procedures are the double ring sign, glucose content of the nasal fluid, Beta-trace protein test or beta 2-transferrin [10].

The double ring sign is the concentric disposal of blood and CSF fluid on a paper towel or a bed sheet. This test is not specific so in order to confirm the leakage other tests are required [11].

The glucose content of the nasal fluid is not recommended anymore because its lack of specificity and false positive results [12].

Beta2- transferring is a highly sensitive and very specific method. To perform electrophoresis a minimum of 0.5mL of liquid are necessary. The test must be performed quickly because it is stable only 4 h at room temperature [13].

Beta-trace protein is produced in the arachnoid cells, choroid plexus, and oligodendrocytes.

The beta-trace protein test has a 92% sensitivity and 100% specificity, but the disadvantage is that if the leak is not permanent collecting enough liquid is challenging [14].

To establish the exact location of the defect, imagistic examinations are necessary.

Contrast CT cisternography can detect active fistulas, but the rate detection is lower in intermittent CSF leaks [15].

MRI examination is better than CT for the diagnosis of brain anomalies and identification of CSF fistulas, but it does not visualize the bone lesion in the skull base [16].

However, the gold standard, CSF leakage, the diagnostic method is an intrathecal injection of fluorescein with the endoscopic identification of the defect [17,19].

The treatment for this pathology is the surgical closure of the dural defect. The surgical procedures can be external (transcranial) or transnasal endoscopic approach [18].

In this paper we analyze a staining test, using methylene blue solution, to identify the CSF leak's location.

Experimental part

We propose a technique to identify the location of the dural defect, is that it is simple and inexpensive using methylene blue (fig. 1).

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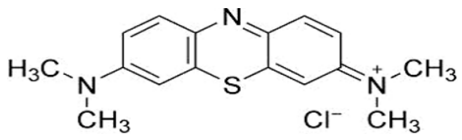

Fig. 1. Chemical formula of methylene blue

The first step is to perform endoscopic transnasal total ethmoido-sphenoidectomy for widening the surgical field and for better visualization of the skull base.

The hemostasis of the area is performed and the surface is cleaned well-using saline solution.

Afterwards, we stained the entire surface of the skull base using cotton pieces soaked in methylene blue. We waited for 3 min, and then we removed the cotton (fig. 2).

The CSF started cleaning the methylene blue from the skull base and nasal mucosa pointing the origin of the fistula (fig. 3).

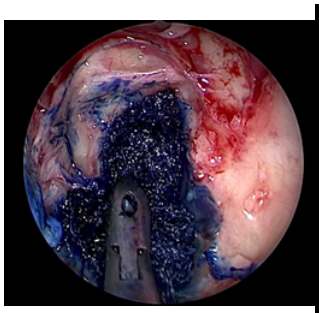

Fig. 2. Staining mucosa with methylene blue

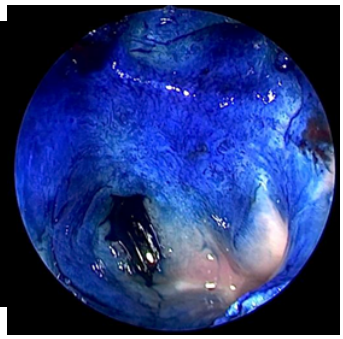

Fig. 3. Methylene blue washed away by CSF, localization of the fistula is possible

The fistula is closed using the underlay technique using cartilage or bone from the nasal septum. The external layer was formed by the left Haddad flap mounted overlay and stabilized using Gelaspon piece with biologic glue.

Results and discussions

For the surgeon to establish the right therapeutical plan, an accurate visual localization of the fistula is necessary. The localization of the CSF leaks can be challenging especially in spontaneous or discontinuous fistulas.

Even if intrathecal lumbar injection with fluorescein is the method of choice to diagnose CSF rhinorrhea, numerous complications related to the dosage of fluorescein are described.

The advantages of the staining test we presented are the fact that it is not time-consuming, it is low-priced, and it has minimum toxic reactions.

Another advantage of the methylene blue staining test is represented by the properties of the substance. Methylene Blue has bacteriostatic and antioxidant action.

Conclusions

The methylene blue staining test is easy to perform and can help the surgeon identify the localization of the CFS fistula even in hard to visualize anatomical areas of the skull base.

If the results are not satisfactory, the test can be repeated. The surface of the mucosa can be cleaned with a saline solution and can be stained again with methylene blue solution.

From our experience, the methylene blue test used in localization of the CSF fistula has proven to be efficient and it also improved the costs and duration of the surgery.

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